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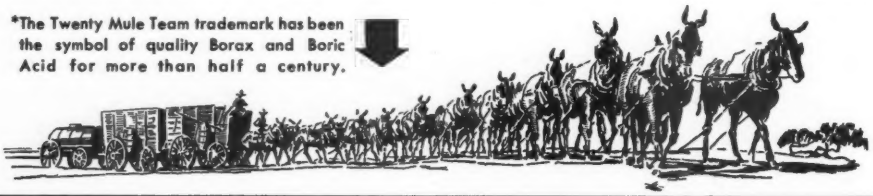

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Vol. 94 APRIL 26, 1941 No. 9

Soil Organic Matter*

By FORD S. PRINCE

University of New Hampshire, Durham, N. H.

SOIL organic matter has long been recognized as the life of a normal soil. Sievers and Holtz[1] state that high crop production, to be permanent, requires practices that maintain soil nitrogen, which is another way of emphasizing the value of organic substance. Yet, in spite of its importance, it seems that not enough emphasis has been placed by research workers upon the behavior of organic matter, especially in relation to the maintenance of a goodly supply of it in the soil.

Nature of Soil Organic Matter

I have been asked to open up the discussion on organic matter and in doing so it seems advisable to cover some of the fundamental concepts concerning the substance and to review briefly some of the basic researches which have recently been conducted to indicate the relationships of these researches to the various concepts now held.

The organic matter of the soil may be roughly divided into two groupings: (1) the fresh or actively decaying material, which may be regarded as very recent additions; and (2) the more slowly decaying portions, or those which have passed through the active stages of decomposition and which are proceeding more slowly toward complete decomposition, which is the ultimate end of any particular piece of organic substance which finds its way into the soil. In this latter stage, the term that has usually been applied is humus, as opposed to the fresh or raw humus stage first mentioned.

It is difficult to draw a dividing line between these two classes of organic matter since, at the moment of death of plant or animal substance, decay sets in and proceeds more or less rapidly depending upon the nature of the substance, the soil, temperature, organisms at hand, and the various other factors involved in the decay process.

Soil organic matter has its origin[2] in the bodies of dead organisms and in the residues of living matter deposited on, or incorporated with, the soil. It is quite impossible to separate this material from the mass of living microorganisms that attack the material upon its incorporation and perform the task of transforming the fresh material into more stable forms.

Hence, soil organic matter may be said to include plant and animal residues together with the bacteria, fungi, actiomyces, protozoa, and other organisms that cause its decomposition. A complete array of this organic substance would, therefore, include dead roots, leaves and stems of plants, bodies of earthworms and other insects, live and dead bacteria, fungi and protozoa and the various decomposition products as well as newly synthesized products of this decomposition that are utilized by the microorganisms that make up the population of any particular soil.

Chemical Nature of Organic Matter

The chemical nature of organic matter in its original state consists of proteins, carbohydrates, fats, resins and waxes, which when decay is finally complete are reduced to CO_2, H_2O, N or NH_3, and a few simple mineral salts. Sooner or later, all of the residues incorporated with the soil at any particular time reach this end stage which is called mineralization. It should be understood, however, that the process is a slow one, probably progres-

* An address delivered at the Conference of Southern New England Fertilizer Salesmen, Amherst, Massachusetts, March 11, 1941.

[1] Sievers and Holtz, Bull. 206, Wash. Agr. Exp. Sta.

[2] C. C. Nikiforoff, 1938 Yearbook, U. S. D. A., p. 929, ff.

sively slower as the end point is approached and that during the decay period many intermediate products are formed. Some of these are the products of the original material, while others are the result of resynthesis due to their use during the process by the microorganisms which feed upon the decomposition products of the material.

The rate of decomposition of various organic substances differs widely, some of them breaking down rapidly while with others the process is slow. In general, the higher the quantity of protein in a substance, the more rapid is its decay. For that reason, clovers decay more rapidly than most of the grasses; young, immature crops decay more rapidly than those that approach maturity or that are allowed to mature before being incorporated with the soil. This does not mean that crops or organic substance low in protein, and high in carbohydrate and woody substances, are not valuable as soil components. What it does mean is that certain types of plants are more active because of a higher protein fraction or their narrow C-N ratio, and that they will yield up their substance for growing crops more quickly than substances with a lower relative proportion of protein or nitrogen.

From the standpoint of permanence of added increments, therefore, the latter class of substances is very valuable, especially because of the physical effects that they produce.

Organic matter, from what has been said, can be construed to be a dynamic or rapidly changing material, a large part of it being in the decomposition stage, with fresh portions being added while the equilibrium between the two will determine the amount in the soil at any given time.

Physical Properties of Humus

Most people agree that humus is a desirable soil component, and that measures should be taken in farming practice to keep the organic content at as high a level as possible. Much of the desirability of organic matter, or humus, comes because of its physical properties and because it imparts these properties in a measure, at least, to the soil itself.

Color is one of the properties that is generally recognized. Dark colored soils have always been associated with high productivity, and while color is not necessarily of itself the cause of the difference in productivity between dark and light soils, it may often be used as one of the criteria denoting productivity.

Dark colored soils absorb heat to a greater extent than light soils, from which more of the heat is reflected. This is a factor which can easily be measured and which is translated into productivity by better germination of seed, earlier starting of crops, and like factors.

Porosity is another attribute of organic matter which is, in turn, imparted to soils, enabling them to hold and store more water for plant growth, and to permit of the entrance of more water into the soil. This latter process is known as infiltration, and the amount of water which soaks into the soil instead of running off the surface is being considered more and more important in view of the necessity for erosion control.

Soil structure is another property which is influenced by organic matter. This is also an important factor promoting the infiltration of water into the soil and in preventing erosion. Soil structure is modified and built up by fibrous rooted plants, by the very nature of the organic matter itself due to contraction and expansion in wetting and drying, and especially because in the end stages of decay, organic matter reaches a colloidal state in which it functions as a cementing agent very similarly to the colloidal clay fractions of the soil. The combined effect of all these impulses is to create more aggregates of soil particles which are water stable and which function more or less as individual grains of soil, making it more loose, friable and water permeable, and at the same time the function of these individual particles in holding water and in absorbing nutrients in the base exchange process is not destroyed.

What this all adds up to, is good tilth in the soil. While tilth may be difficult to exactly define, it means that desirable physical properties in the soil have been attained as the result of a suitable supply of organic matter, which imparts desirable structure, the ability to absorb and hold moisture, and which permits of easy cultivation and tillage practices.

Chemical Effects of Organic Matter

We have already mentioned the chemical properties of organic matter itself. From the point of view of its action in the soil, organic matter serves as a source of N-P-K, the three principal plant food nutrients. It is also a source of supply of calcium magnesium, iron, and most of the rare or trace elements about which we hear so much.

Because of its colloidal nature, it acts as a vehicle in functioning in the base exchange complex, and increases the absorption of such materials as ammonia, potash, etc. in applied

fertilizers, later on yielding these up to plants in their growth.

Besides serving as a source of supply of plant food, certain acids are formed in its decay which exert some effect upon native soil minerals, making them available to crops.

Another function of organic matter is to furnish vitamin substances for plant life during this decay process. While this function may not be so well understood, the fact has been abundantly demonstrated by recent investigators.

Climatic Influences on Soil Organic Matter

I have said enough to convince most people, I think, that organic matter plays its vital role in all our normal soils, that it gives life to these soils, that it is the chief factor in making the soil a dynamic body, teeming with life and change.

Now, what I would like to do, since I am at least presuming that you agree with me so far, is to inquire into the factors that govern the amount of organic matter in soils, the causes of its depletion, and the means at our disposal in effecting increases of it in our soils, such as, for example, the effect of cropping, of rotations, of plowing under manure or green manures, and of applying fertilizers to increase growth, which at the same time increase crop residues.

Probably the best work that has yet been done upon the effects of factors such as climate upon the amount of organic matter in soils has been turned out by Jenny[3] and reported in Mo. Res. Bull. 152.

In this study, Jenny collected soils from different climatic areas of the United States, after which he made analyses for both organic matter and nitrogen. His reason for making the study was ascribed to the fact that, in the common rotations practiced in Missouri, constant losses of organic matter occurred.

Without going into too much detail on Dr. Jenny's work, I will present his general conclusions:

1. Within regions of similar moisture conditions, the nitrogen and organic matter content of upland, terrace, and bottom land soil, including both prairie and timber vegetation, decreases from north to south.

2. This decrease can be represented as an exponential function.

3. For each 10° C. fall in annual temperature, the average total nitrogen and organic matter increases two to three times, provided the precipitation-evaporation ratio is kept constant.

4. The C:N ratio seems to become wider with decreasing temperature.

5. The general importance of the soil-forming factors in determining soil nitrogen is as follows: (1) Temperature, (2) Vegetation, (3) Topography, (4) Parent material. These are stated in order of their decreasing importance.

What all this means apparently is that climatic factors are tremendously important in governing the supply of organic matter, and if we attempt to increase the amount from, say, 4 to 5 per cent, where the norm for the climate is 4 per cent, we are under a tremendous handicap because increments which are added over and above certain amounts are subject to undue losses. This fact has been substantiated by Blair, who submits that additions of organic matter are made at the expense of large losses.[4] There may be some short cuts.

Wheeting[5] reports in Soil Science, Volume 44, the changes in organic matter in western Washington soils as a result of cropping. In his study, samples were collected from cultivated areas and from similar nearby uncropped sections; uncropped areas were subject to slash cutting and burning.

Seventy-three pairs of samples representing seven soils series were analyzed, and an accurate history of each soil was taken. Some of the data are presented in Table 1.

Table 1

Changes in Organic Matter Due to Cropping

Agr. History	Per Cent Organic Matter	
	Amount	Change
Rotation, 20 years, with manure	8.78	+3.76
Stump pasture	5.02	
Truck crops, 10 years, heavy fert.	8.64	+4.66
Cut over	3.98	
Rotation, 40 years, no fert.	5.86	—3.52
Cut over—in Ferns	9.38	

Wheeting, L. C., Washington Exp. Sta., Soil Sci. **44**, pp. 139-49 (1937).

In discussing his results, Wheeting says:

"1. The results indicate that, contrary to the previously reported data, there has been an increase in the quantity of organic matter under cropping in western Washington. For all samples examined, this increase amounts to about 28 per cent.

"2. The quality of the organic matter is much improved as a result of cropping. This

[3] Jenny, Hans, Res. Bull. 152, Mo. Agr. Exp. Sta.

[4] Blair, A. W., Jour. Am. Soc. Agron. **25**, 540-547.

[5] Wheeting, L. C., Soil Sci. **44**, pp. 139-49 (1937).

is probably associated with the change in the soil from the forest type to the cereal type of organic residue.

"3. The greatest increases in quality of organic matter as a result of cropping occur under the better systems of soil management, which add organic material to the soil regularly. Under such management, western Washington soils have maintained a superiority over virgin soils for at least a 45-year cropping period."

Salter and Green[6] in the Journal of the American Society of Agronomy, Vol. 25, report a study of soil from certain long time fertility plots at the Ohio Experiment Station at Wooster.

These men contrast five different cropping systems in relation to losses of organic carbon and nitrogen, including continuous corn, continuous wheat, continuous oats, along with a three-and five-year rotation. (Table 2.)

Table 2

Influence of Cropping System

System Followed	Annually: Per Cent Loss Organic Carbon	Annually: Per Cent Loss Nitrogen
Continuous corn	3.12	2.97
Continuous wheat	1.44	1.56
Continuous oats	1.41	1.45
5-yr. rotation corn, oats, wheat, clover, timothy	0.85	1.06
3-yr. rotation corn wheat, clover	0.60	0.69

Salter and Green, J. Am. Soc. Agron. (1933), from Ohio Long Time Experiments.

The three-year rotation exhibited a smaller loss in both organic carbon and nitrogen than the five-year rotation and both rotation systems showed smaller annual loss than the three series of plots cropped continuously. These crops ranked in the order of oats, wheat and corn in increasing amounts of organic carbon and nitrogen lost.

They attribute the apparently better results of the three-year rotation of corn, wheat, and clover as opposed to the five-year rotation of corn, oats, wheat, clover, and timothy to the better effects of the clover in maintaining organic carbon and nitrogen, believing that clover one year in three is better in this respect than clover and timothy two years in five.

Table 3

Influence of Hay Crops

	Annual Gain, Per Cent: Organic Carbon	Annual Gain, Per Cent: Nitrogen
Hay in 5-year rotation	1.36	0.64
Hay in 3-year rotation	3.25	2.87

Salter and Green, J. Am. Soc. Agron., pp. 622-30 (1933).

[6] Salter and Green, Jour. Am. Soc. Agron. **25**, pp. 622-30 (1933).

They present data (Table 3) to indicate that for their conditions this is true, showing that the hay in the three-years rotation caused a gain of 3.25 and 2.87 per cent in organic carbon and nitrogen respectively, while in the five-year rotation, the corresponding gains are but 1.36 and 0.64 per cent. All of these studies were made on unfertilized and unmanured plots although one-half of each series was limed and, in the tables shown, the data for the limed and unlimed portions are averaged.

Table 4

Gains Due to Manure

	Total Gain—32 Yrs. Pounds per Acre: Organic Carbon	Total Gain—32 Yrs. Pounds per Acre: Nitrogen
Unlimed	4,968	493
Limed	5,694	335

Total manure applied—234 tons.
Organic carbon content—46,400 lb.
Nitrogen content—1,872 lb.

Salter and Green, J. Am. Soc. Agron. (1933).

In this paper Salter and Green present data (Table 4) on accumulations of organic carbon and nitrogen due to manures applied over the 32-year period studied. In the unlimed portion, 234 tons of manure, carrying 46,400 pounds of organic carbon and 1,872 pounds of nitrogen, were applied over the period. The resulting comparisons showed these plots to be richer on the unlimed portion by 4,968 and 493 pounds of organic carbon and nitrogen respectively, while the limed portion showed gains of 5,694 pounds of organic carbon and but 335 pounds of nitrogen. This would seem to show that lime has some effect on organic carbon increase, but that it causes a slight loss in nitrogen compared with no lime.

These authors conclude in general (a) that any given type of culture will cause a certain fraction of organic matter to be lost. They also state (b) that the gain arising from crop residues will be proportional to the amounts already in the soil, since they will vary with the size of crop and the latter will be more or less proportional to the amounts of nitrogen and organic matter present.

Stauffer[7] also presents data (Table 5) to compare different cropping and soil management systems on the amount of organic carbon in the soil and, at the same time, among other things, indicates what effects this has on the water-holding capacity of the soils. Corn continuously showed a loss in organic carbon, in comparison with grassland on the edge of the

[7] Stauffer, R. S., Jour. Am. Soc. Agron. **28**, pp. 900-906 (1936).

(Continued on page 24)

Use of Liquid Fertilizers for Growing Vegetables*

By V. A. TIEDJENS

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USE of liquid fertilizers as a starter solution and for side-dressing vegetable crops is a relatively new procedure. Recent research work at the New Jersey Agricultural Experiment Station, however, has developed considerable data on the formulation and efficiency of liquid fertilizers, as well as amounts and methods of application.

The New Jersey experiments have shown that liquid fertilizers cannot be applied in the same way to all vegetable crops. Since such crops as snap beans and sweet corn mature in a short season, most of their plant food should be applied when the crops are planted. This can be done by plowing under dry fertilizer and using liquid only as a starter solution. A starter solution can be used at planting with such long-season crops as tomatoes, lima beans, cabbage, and sweet potatoes, followed with side-dressings of liquid fertilizers at intervals of two or three weeks.

Starter Solutions

Formulas. Starter solutions can be made from a wide variety of fertilizer materials. Our studies, however, indicate certain properties are essential for best results.

In the first place, the starter solution should have a reaction of pH 5.0 or somewhat higher. Starter solutions made with superphosphate or triple superphosphate as the source of phosphoric acid have a reaction of about pH 3.5, and have been very unsatisfactory. In fact, they definitely injure tomato plants. If superphosphates are used in the fertilizer mixture, they should be neutralized with some ammonia liquor, lime, or other alkaline material. This is usually done in the manufacture of complete fertilizers so that most commercial fertilizers will make starter solutions having a satisfactory pH value.

The second principle to keep in mind is the relation between the nutrient content of the starter solution and its influence on the concentration of the soil solution around the seed or seedling. It seems advisable to use starter solutions which carry the desired quantity of nutrients and at the same time cause the smallest increase in the concentration of the soil solution. Experiments to evaluate the importance of this factor are still in progress. The work of White and Ross, Jour. Agr. Research, *95*, 81-99, indicates that ammonium phosphate, ammoniated superphosphate, urea, potassium nitrate, and potassium sulphate are sources of nutrients that cause very small increases in the concentration of the soil solution. All of these materials have given very good results in starter solutions.

The following are two examples of concentrated high-nitrogen mixtures (13-26-13 and 10.5-21.5-21.5) that (1) are quickly soluble; (2) give good results on either limed or unlimed soils; (3) have a suitable pH for a starter solution; and (4) are well suited for side-dressing purposes, as well.

	13-26-13 Pounds	10.5-21.5-21.5 Pounds
Ammo-Phos, 11% N, 48% P_2O_5	1,092	900
Muriate of potash, 60% K_2O...	440	715
Sulphate of ammonia, 20.5% N	100	80
Nitrate of soda, 16% N.....	120	100
Uramon, 42% N.....	248	205
	2,000	2,000

These mixtures contain approximately 1.0 per cent CaO derived from the Ammo-Phos and Uramon fertilizer compound. They have, nevertheless, given excellent results on unlimed as well as limed soils when used in starter solutions.

The calcium content of the starter solutions may be increased by adding calcium sulphate to the mixture. It, however, is impossible to get much calcium in solution, due to the high content of phosphoric acid and relatively high reaction, pH 5.0. The most satisfactory and economical way to provide calcium when using starter solutions and liquid fertilizers is to follow a good liming program.

For Transplanting. The starter solution is made by dissolving 2 to 10 pounds of fertilizer, depending on the analysis, in 50 gallons of water. This solution is then used instead of water for setting out the plants. If dry fertilizers are to be used in fertilizing the crop, the

* Reprinted from DuPont Agricultural News Letter.

best procedure is to spread it broadcast before plowing and depend on the starter solution to give the plants a good start. The most striking results from starter solutions will be secured on soils of low and medium fertility.

For Seed Planting. Starter or transplanting solutions can be used when seed is sown. Good crops of sweet corn, snap beans, and lima beans have been produced by drilling with the seed, 25 to 50 pounds of special fertilizer mixtures in 50 gallons of water, applied at the rate of 200 gallons per acre. While 200 gallons of solution per acre is usually an economic application, it is desirable to use more water, if possible, because a greater dilution will give better distribution of the fertilizer. If more than 200 pounds of fertilizer are used, part of it may be applied in the drill with the seed and the remainder in one or more side-dressings. Not more than 100 pounds of the 13-26-13 or the 10.5-21.5-21.5 mixtures, previously mentioned, are needed per acre above of lima or snap beans.

Solutions for Side-Dressings

Liquid fertilizers for side-dressings are similar to starter solutions except they are very much more concentrated. This makes it possible to apply substantial amounts of plant food per acre without using large amounts of water. Thus, 50 pounds of 13-26-13 can be dissolved in 50 gallons of water. If such a solution is used at the rate of 200 pounds per acre, it is equivalent to an application of 520 pounds of 5-10-5 per acre.

Formulas. Fertilizer solutions for side-dressing on well-limed soils need contain very little, if any, calcium. If ammonium phosphate (Ammo Phos) is used in mixtures, salts that dissolve immediately can be used in the solution. Double- and triple-strength fertilizer mixtures can be used for side-dressing purposes.

The 13-26-13 and 10.5-21.5-21.5 listed above have given good results when used as side-dressings on limed and unlimed soils. Formulas for two additional fertilizers having different plant-food ratios are given below. One is a lower-nitrogen mixture (7.6-32-16) which has been found satisfactory for side-dressing purposes. The other, a much higher analysis (24-26-16), when applied in appreciable amounts, must be used on well-limed soils. It will cause trouble on an acid soil.

	7.6-32-16 Pounds	24-26-16 Pounds
Ammo-Phos, 11% N, 48% P_2O_5	1,000	....
Muriate of potash, 60% K_2O	534	....
Double superphosphate, 48% P_2O_5	340	....
Gypsum	26	....
Uramon, 42% N	100	350
Di-ammonium phosphate, 20% N, 50% K_2O	....	980
Potassium nitrate, 13% N, 44% K_2O	....	670
	2,000	2,000

Magnesium Salts, Borax, and Manganese Sulphate. Where growers have determined a need for magnesium, addition of 100 pounds of magnesium sulphate (Epsom salts) per ton of fertilizer used in the side-dressing solution is sufficient. Dolomitic limestone may be used to supply magnesium at considerably less cost. Should boron or manganese deficiency develop, 10 to 20 pounds of borax or 20 pounds of manganese sulphate may be dissolved in the water which is applied per acre.

Liming Program

All of the formulas indicated are very low in calcium because it is impossible to have substantial amounts of both calcium and phosphoric acid in solution. Calcium is a very essential plant food. Large amounts are needed in any well-balanced fertilizer and soil-fertility program. If liquid fertilizers are to be used, it will be necessary to follow a good liming program. If this is done, both the calcium and magnesium requirements of the crop will be supplied through the use of dolomitic limestone.

Equipment

For Applying Starter Solutions. No special equipment is needed to apply starter solutions *used at transplanting.* The regular water tank with which transplanters are equipped is satisfactory. *For seed-sown crops,* a 25- to 50-gallon tank, with a piece of hose and a spout to carry the solution into the drill with the seed, can be mounted on the planter in place of the dry-fertilizer hopper. This equipment can be made in the farm workshop.

For Applying Side-Dressing Liquids. A riding cultivator can be equipped with a tank to direct the liquid to each side of the plants, the open end of the hose being attached just back of the cultivator teeth. *For tractor cultivators,* a 100- to 150-gallon tank can be mounted at the rear of a tractor just above the draw-bar, and equipped to distribute the solution to the cultivator teeth. The liquid is distributed as close to the plants as the foliage permits. Late applications may be made down the middle of the row.

By removing the nozzles from *spraying equipment,* a stream the size of a lead pencil on each side of the row will apply 200 pounds of

(Continued on page 22)

Developments in Fertilizer Anti-Trust Suit

THE National Fertilizer Association, under date of April 15th, has summarized the recent developments in the anti-trust suit brought by the U. S. Government against the Association and a number of individual fertilizer companies and their officers.

1. *Pleas in Abatement.* At a session of the Federal Court held at Winston-Salem on April 8th, pleas in abatement which had been made by a number of the defendants were argued by Government counsel and defense counsel. It was contended by the pleas that the indictment was not valid because the grand jury which returned the indictment on February 10th was not legally in existence at that time, the necessary court orders not having been issued for continuing the grand jury beyond the term in which it was empaneled. Judge Hayes overruled the pleas, holding that the special term of Court in and for which the jury was empaneled (in January, 1940) continued up to the time the grand jury was discharged (on March 10, 1941) after return of the indictment, although two regular terms of the Court (May and November, 1940) had intervened. No additional order for continuing the grand jury, he held, was necessary.

2. *Disposition of Subpoenaed Records.* The Government's motion to impound certain records which had been produced for use by the grand jury in response to subpoenas duces tecum was argued by Government counsel and by counsel for defendants on April 8th. The Court indicated his decision to impound those records which had been introduced in evidence and had been read in whole or in part before the grand jury and those records which had been specifically identified or referred to before the grand jury. All other records, he said, should be returned, at the expense of the Government, to those persons who had produced them. The impounded records are to be subject to examination by Government counsel and defense counsel. The Court gave instructions that an order be prepared along these lines.

This order will not apply to the Association's records. On March 29th the Court signed an order, consented to by counsel for the Government and counsel for the Association, whereby all the Association's subpoenaed records are to be returned, at the expense of the Government, to the Association's offices in Washington for its use and subject to examination there by Government counsel. The records, or so much thereof as Government counsel may designate, are to be returned to the Clerk of the Court at Winston-Salem 30 days in advance of the date set for trial of the case and to be subject to examination there by Government counsel, by Association counsel, and by any person designated in writing by the Executive Secretary of the Association.

3. *Release from Oath of Secrecy.* As an aid in the preparation of the defense, Charles J. Brand, Executive Secretary and Treasurer of the Association, applied to the Court for a release from the oath of secrecy imposed upon him when he testified before the grand jury. The Court has granted an order permitting him to disclose to his individual counsel and to counsel of and for the Association, and to its officers, directors, and members of its Executive Committee any statement of facts made by him under oath to the grand jury. Other witnesses who appeared before the grand jury have a right to make similar applications and may wish to do so as a preparation for defense. Counsel for some of the other defendants have announced that they will make a motion to release from the oath of secrecy some other witnesses who testified before the grand jury, such as witnesses who were made defendants in the indictment and witnesses who were representatives of corporations which were made defendants in the indictment.

4. *Motion to Quash.* Counsel for some defendants have announced that a motion will be made to quash the indictment on the ground of duplicity, that is, charging two or more offenses in the same count. This motion is to be argued before the arraignment date, May 12th.

5. *Pleas by Counsel.* Upon request of counsel the Court has agreed to permit any defendant desiring to do so to enter a plea, at the arraignment on May 12th, through counsel, thereby avoiding the necessity of some expense and a personal trip to Winston-Salem at that time. Efforts are now being made to work out practical arrangements for such handling of the pleas with the least possible trouble or expense to the defendants.

6. *Board Meeting.* At a meeting of the Board of Directors held on April 10th, the

(Continued on page 22)

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Sodium in Cotton Fertilizers

By E. D. Matthews, Georgia Experiment Station, Experiment, Ga.

Recent work at the Georgia Experiment Station shows that sodium, one of the more common chemical elements, is beneficial to cotton under ordinary conditions. Whenever cotton is grown on soils which do not have a large supply of potash, sodium in the fertilizer will act in the same way as potash. It is not more than about 40 per cent as effective as potash. It should not be used as a substitute for potash, but on potash-hungry land it will make the potash in the fertilizer more effective.

Most Georgia soils respond well to potash, and where potash is needed, it is well to use sodium in cotton fertilizers. Fertilizer materials that contain sodium include:

Carnallit, not used in mixed fertilizers, but from which muriate of potash is refined.

Low-grade muriate of potash or manure salts.

50 per cent muriate of potash; may contain up to 10 per cent sodium.

Kainit, a low-grade potash material which is very good for most crops, but no longer on the market.

Common salt or rock salt, the commonest form of sodium, which is the per cent sodium when pure, but is not commonly used in fertilizers.

Nitrate of soda, which in addition to nitrogen contains about 25 per cent sodium.

Since nitrate of soda is so widely used, it is probably the most convenient source of sodium. It should be particularly beneficial on soils that do not have or do not receive large amounts of potash. The sodium in it probably accounts for the fact that nitrate of soda has generally been one of the most important sources of nitrogen for crops, and is so extensively used in agriculture.

The benefits from sodium have been shown in Georgia for cotton, and in other states for sweet potatoes, oats, rape, buckwheat, cucumbers, and such root crops as turnips, rutabagas, radishes, beets, sugar beets, mangels, and carrots. Although not yet demonstrated, it is probably valuable for most other crops also.

Because soils vary greatly both in natural potash and in the amount of potash applied in the fertilizer, it is impossible to make a general recommendation as to how much sodium should be used in fertilizers. Cotton that receives all or part of its nitrogen from nitrate of soda probably receives enough sodium unless the soil is extremely deficient in potash.

NEW N. F. A. BOOKLET

"Putting Plantfood to Work" is the title of a new 16-page booklet issued by the National Fertilizer Association. This is a textual summary of the motion picture of the same title which was prepared by the Association. The methods of applying fertilizer to many crops are discussed and illustrated. Distribution is being made through sales in quantity to the members.

NEW ADDRESS FOR BAKER CHICAGO OFFICE

On April 21st the Chicago office of H. J. Baker & Bro. was moved from 332 South La Salle Street to 208 South La Salle Street. The telephone number at the new offices is Central 4355-6.

AMENDMENTS TO NORTH CAROLINA FERTILIZER LAW

The bill in the North Carolina legislature (reported in our April 12th issue) to make important changes in the fertilizer law of that State was passed by both houses after being amended in regard to minimum grades. A plant food content of 14 per cent was established as the minimum but all fertilizers containing two or three of the principal fertilizer ingredients (N, P_2O_5 and K_2O) must be branded "Low Grade" if the total plant food content is less than 16 per cent. In addition, each bag must carry a red tag, reading: "This is a Low Grade Fertilizer. It costs too much per unit of nitrogen, available phosphoric acid, and potash, because it contains only 14 or 15 units (whichever the case may be) of these plant foods. You are paying too much for bagging, freight, labor, etc., on too much inert material."

POTASH CO. OF AMERICA MOVES SALES OFFICE TO NEW YORK

The Potash Company of America has announced that on May 1st the general sales office of the company will be transferred from Baltimore to New York City. The new offices will be located at 50 Broadway. George E. Petitt, vice-president in charge of sales, will head the staff at the new headquarters. A regional office will be continued in Baltimore under the direction of F. E. Smith, Jr.

MARCH SULPHATE OF AMMONIA PRODUCTION

Production of by-product sulphate of ammonia during March continued at the established level of about 2,000 tons per day. The U. S. Bureau of Mines reports a March output of 64,524 tons, compared with 58,360 tons in February, and 56,059 tons in March, 1940. For the first quarter of 1941, a total of 187,553 tons was produced, an increase of 10 per cent over 169,927 tons for the same period of 1940.

By-product ammonia liquor showed production figures of 2,745 tons (NH_3 content) in March, 2,341 tons in February, 2,252 tons in March, 1940. For the first three months of the year, the output was 7,750 tons in 1941 and 6,923 tons in 1940.

NEW LINK-BELT RUBBER-TREAD RETURN IDLER FOR BELT CONVEYORS

The development and manufacture of a new line of rubber-tread idlers for supporting the return run of 14 to 60 inch wide belt conveyors, is announced by Link-Belt Company, 220 S. Belmont Ave., Indianapolis, Ind.

Each complete idler consists of from four to twelve 6-in. diameter rubber-tired rolls suitably spaced and mounted on a Friction Fighter roller-bearing-equipped steel tube that will fit into the same supporting hangers as the regular Link-Belt return idler roll.

The individual rolls consist of a renewable extruded rubber tire clamped between two steel discs firmly held together by three round-head bolts. As the rubber tire is made split, it can readily be replaced with a new tire when required, by just removing three nuts, instead of having to strip the entire unit and other rolls off the tube, which would be necessary if the rolls had tires that were made endless.

The new idlers are especially recommended for conveyors handling corrosive, abrasive, wet, or sticky materials, such as salt, coke, phosphate rock, fertilizers, wet coal, etc., because (1) there is only a rubber-to-rubber contact between return idler and the underside of conveyor belt, and (2) as the kneading action of the rubber treads keeps the material from building up, also helping to break up and loosen ice forming on the belt in freezing weather.

A copy of new Folder A-640, giving sizes, dimensions, list prices, is available to any interested reader upon request addressed to the manufacturer.

Placement of Fertilizers for Cotton

By H. P. Smith, Chief, Division of Agricultural Engineering, Texas Agricultural Experiment Station, College Station, Texas

Results of the fertilizer placement and soil disturbance studies at the Texas Agricultural Experiment Station indicate that disturbing the soil under the seed to apply fertilizer is not good practice, because lower stands are thereby obtained than where the fertilizer is applied to the side and below the seed level without disturbing the soil under the seed.

In fact, considerably better yields as well as better stands of cotton were secured by the side-placement of the fertilizer. The best results were secured when the fertilizer was placed 2 inches to the side and 2 inches below the seed level. Where the fertilizer was placed to one side only, the result was almost as good as when placed at both sides. These experiments show also that the soil disturbance is one of the principal limiting influences on germination inasmuch as in those tests where the soil was disturbed without placing any fertilizer, the stands were not so good as where the fertilizer was applied in the process showing that the fertilizer so placed is somewhat beneficial to the germination. On the contrary in those tests where the disturbance of the soil was underneath the seed, the fertilizer tended to reduce the stand as against the check where the soil was disturbed without placing the fertilizer. These results clearly indicate that the applications of fertilizer made below the seed are not efficient.

Other experiments show that for the best use of fertilizer the application should be made at time of planting. Hence, it is essential that the application be made to the side and well below the seed level in order to avoid disturbing the firm seedbed which is necessary for a good stand.

For several decades cotton farmers in the more humid regions of the Cotton Belt have followed the practice of preparing the seedbed by bedding on the fertilizer early enough so that rains will settle the soil before cottonseed is planted. The disadvantage of this practice is in the reduced effect of the fertilizer as compared with applications made at the time of planting. Hence, the development of the better practice of applying the fertilizer to the side and below the seed level at the time of planting.

These results are similar to those found in other States; however, the Texas Experiments have not included in addition to planting-time applications, small side dressings of fertilizer during the growing of the plants, whereas in some states such side dressings, when the plants are about 4 inches high, have shown profitable increases.

The problem of making the proper placement of fertilizer is important and requires suitable machinery. Only recently some of the implement manufacturers have placed on the market efficient placement machinery, particularly for tractor-mounted planters, and with it the planting and fertilizer placement are both accomplished at the same time. If such machinery is not available or some substitute improvised, then the small cotton farm of using one-horse walking planters and one-horse walking fertilizer distributors may be necessary. In such cases the better practice would be to bed rather early and give the soil time to settle, then plant, seeing that the seed get down to the firm soil at the bottom of the furrow made by the opener on the planter. As another operation set the fertilizer distributor to open a furrow and place the material 2 inches to one side of the seed and 2 to 3 inches deeper than the seed level. Bulletin 548 of the Texas Agricultural Experiment Station discusses many of the problems connected with fertilizer placement.

BRADLEY & BAKER

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FERTILIZER MATERIALS MARKET

NEW YORK

Movement of Mixed Fertilizers Causes Better Demand for Fill-in Material. Export Licenses for Sulphate of Ammonia and Potash Hard to Obtain. Organic Prices Higher.

Exclusive Correspondence to "The American Fertilizer."

NEW YORK, April 22, 1941.

The continuance of fair weather has resulted in heavy deliveries of mixed fertilizers quite generally. This has resulted in a better demand for certain raw materials.

The movement of nitrate of soda is heavy, along with the better demand for mixed fertilizers, and in many cases the fertilizer manufacturers have called upon the potash people for some quick deliveries.

It is now generally felt that export licenses for sulphate of ammonia and high grade potash salts will be very hard to obtain. This should mean that for some months the supply of sulphate of ammonia should be sufficient for domestic demands.

Nitrate of Soda

No change in price, same being maintained at $27.00 bulk basis, with fairly heavy movement.

Superphosphate

Price unchanged.

Potash

Some demand for quick delivery with most producers somewhat behind in their shipping schedule.

Nitrogenous

Market firm with considerable quantity booked in advance for the new fertilizer year.

Bone Meal

Nominal quotation on South American raw bone meal continues at $36.00, subject to freight space being obtainable.

Tankage

This market continues on a firm basis, and while last business was done at $3.10 ($3.77 per unit N) and 10 cents for unground 9/10 per cent material, sellers are now asking $3.25 ($3.95 per unit N) and 10 cents.

Dried Blood

The lowest quotation in the New York market is $3.50 ($4.25½ per unit N), with some sellers holding their ideas at $3.75 ($4.56 per unit N). Offerings are limited. South American is not quoting because of the lack of freight space. Where spot stocks of the imported material exist, quotations are $3.25 and $3.50 ($3.95 and $4.25½ per unit N), at the port, according to views of the individual sellers.

Fish Scrap

Last trading was done at $4.25 ($5.16½ per unit N) and 10 cents on the usual "if made" conditions. There is further buying interest in the market at this level but producers have withdrawn and there are no offerings available.

ATLANTA

Late Spring Extends Shipping Season into May. Tonnage About Normal. Prices Steady with Imports Greatly Curtailed.

Exclusive Correspondence to "The American Fertilizer."

ATLANTA, April 22, 1941.

A late spring throughout most of the South has extended the fertilizer shipping season well into April, with indications that activity will continue through early May. This is especially true of the Piedmont sections of the Southeast.

The top dressing season is now opening up and will augment the regular fertilizer shipping period.

It is a little early to forecast what the ultimate tonnage consumption will amount to, but preliminary estimates seem to indicate the volume will be up to that of the last year or so.

There has not been any very radical change in prices on various materials, in spite of the fact that ocean freights have advanced and due to the war this country is being forced more and more on a self-contained basis. About the

FERTILIZER MATERIALS

LET US QUOTE YOU ON YOUR REQUIREMENTS OF THESE MATERIALS

PHOSPHATE ROCK

SUPERPHOSPHATE

DOUBLE SUPERPHOSPHATE

NITRATE *of* SODA

SULPHURIC ACID

SULPHATE *of* AMMONIA

BONE MEALS

POTASH SALTS

DRIED BLOOD

TANKAGES

COTTONSEED MEAL

BONE BLACK

PIGMENT BLACK

SODIUM FLUOSILICATE

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East St. Louis, Ill.
Greensboro, N. C.
Havana, Cuba
Houston, Texas
Jacksonville, Fla.
Montgomery, Ala.
Nashville, Tenn.
New Orleans, La.
New York, N. Y.
Norfolk, Va.
Presque Isle, Me.
San Juan, P. R.
Sandusky, Ohio
Wilmington, N. C.

only source of outside supplies that we have at this time are from the Indies and South America and this is confined largely to organics of one source or another.

South American Blood.—$3.10 per unit of ammonia ($3.77 per unit N), c.i.f.

Tankage.—$3.25 ($3.95 per unit N) and 10 cents, c.i.f.

Domestic Nitrogenous Tankage.—$1.70 ($2.06½ per unit N), f.o.b. western producing points.

Acidulated Fish Scrap.—Nothing offered with bids at $3.00 per unit of ammonia ($3.64½ per unit N) and 50 cents per unit of available phosphoric acid.

Dried Scrap.—$54.00 per ton, f.o.b. producing points.

Nitrate of Soda.—No change in price.

Sulphate of Ammonia.—Demand active, with resales bringing around $1.00 per ton premium over the nominal schedule.

CHARLESTON

Mixed Fertilizer Shipments Somewhat Lighter. Between-Seasons for Nitrate. Blood Prices Increase.

Exclusive Correspondence to "The American Fertilizer."

CHARLESTON, April 21, 1941.

The movement of mixed fertilizers continues fairly heavy, although it has slowed up somewhat in the past week. Orders for nitrate of soda on contracts have slowed up as this is the in-between season. Sulphate of ammonia and potash continue scarce.

Nitrogenous.—Domestic material can be obtained around $2.30 ($2.79½ per unit N) at southeastern ports.

Blood.—Around $3.50 ($4.25½ per unit N), bulk Chicago; $3.00 (3.64½ per unit N), bagged, c.i.f. Atlantic ports, but freight space except to ports Norfolk north continues extremely scarce.

Fish Meal.—No spot material being offered. Dried menhaden scrap for future is offered at $4.25 ($5.16½ per unit N) and 10 cents per unit B.P.L.

Cottonseed Meal.—Around $30.00 for 8 per cent at Atlanta, and $25.50 for 8 per cent at Memphis.

BALTIMORE

Manufacturers Shipping to Capacity, with Some Labor Shortage. Material Supplies Adequate. Bag Prices Still High.

Exclusive Correspondence to "The American Fertilizer."

BALTIMORE, April 22, 1941.

With material moderation in the weather going into the second summery week, the spring season has at last gotten under way, with result that all manufacturers are crowded to capacity, and some are experiencing labor shortage in getting out their shipments of mixed goods. The season, however, has not yet advanced far enough to create any shortage in raw materials, but the market is ruling firm all the way down the line.

Ammoniates.—Tankage for feeding purposes is in good demand, and the market is slightly higher, figuring about $3.35 per unit of nitrogen, and 10 cents per unit of B.P.L., f.o.b. basis Baltimore. South American ground dried blood is quoted on the same basis.

Nitrogenous Material.—The demand for this article continues to lag, and the nominal market remains unchanged at $2.55 to $2.65 per unit of nitrogen, f.o.b. Baltimore.

Sulphate of Ammonia.—Fertilizer manufacturers are conserving their supplies and there has been practically no re-sale demand in this section. Some of them, however, who were

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Sulphate of Ammonia

Ammonia Liquor :: Anhydrous Ammonia

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unable to get their full requirements, from first hands, are using nitrate of soda in their mixtures and this will prevent a run-away resale market for domestic consumption. It is reported that export licenses are more difficult to secure than in the past, and with the tightening up of Government export restrictions and steel mills running to capacity, there may be a larger tonnage available for domestic use for next season than during the past 12 months.

Nitrate of Soda.—Withdrawals are more active, and will probably continue to increase as the season advances. The market is firm and this material is still quoted at $29.40 per ton of 2,000 lb., in 100-lb. bags, with usual differential for 200-lb. bags and in bulk, f.o.b. port warehouse.

Fish Scrap.—There has been little activity in new catch of menhaden fish scrap, and producers are holding firm at about $5.15 per unit of nitrogen and 10 cents per unit of B.P.L., f.o.b. fish factories, for shipment subject to catch.

Superphosphate.—All manufacturers are now busy shipping against previously booked contracts, and the market remains firm at $8.00 per ton of 2,000 lb., basis 16 per cent, for run-of-pile. and $8.50 for flat 16 per cent grade, no charge for excess, both in bulk, f.o.b. producers' works, Baltimore.

Bone Meal.—The demand for this material continues light, as all manufacturers have provided for their current requirements. Therefore, the market is quoted strictly nominal at $32.00 to $34.00 per ton, for domestic 3 and 50 per cent steamed bone meal, and $31.00 to $32.50 for 4½ and 47 per cent South American raw bone meal, f.o.b. Baltimore.

Potash.—Up to the present time there has not been any demand for re-sale potash, from which it is evident that domestic manufacturers are taking care of manufacturers' current legitimate requirements, and there will probably be no change in price until producers are ready to quote for another year.

Bags.—The market on burlap for early delivery continues to rule firm, due to the scarcity of supplies on account of British vessels having been taken off the Calcutta run, but with new charters booked for April shipment from Calcutta the shortage will probably be relieved when vessels sailing from Calcutta during this month start arriving in this country. The present market for early delivery is around $195.00 per thousand for plain, new 10 oz. basis 40 cut 54 in., delivered Baltimore. Due to the heavy increases that have taken place during the past four weeks, buyers are going very slowly in purchases for future delivery, preferring to await further developments rather than anticipate that the present high market will prevail over the latter part of this year.

WILMINGTON

Late Shipping Season Continues at Peak. Potash and Sulphate of Ammonia in Demand for Fill-in Purposes.

Exclusive Correspondence to "The American Fertilizer."

WILMINGTON, April 21, 1941.

The movement of mixed fertilizers has been very active for the past two weeks, during which period the peak of the season was probably reached. The season this year has been about two weeks late and there is yet a large tonnage of tobacco fertilizer to move.

The demand for filler materials has begun to appear and there is a decided scarcity of potashes. Most of those fortunate enough to have resale lots are naming prices above the potash list.

The movement of nitrate of soda through

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HIGRADE MURIATE OF POTASH
62/63% K_2O
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UNITED STATES POTASH COMPANY, INC., 30 ROCKEFELLER PLAZA, NEW YORK, N. Y.

March was very satisfactory, but we had the usual seasonal decline in shipments during April.

Sulphate of ammonia is coming in for more demand and limited tonages are being offered for shipment to interior points at $31.00 basis port. It is the general opinion now that the total shipments this year will run very close to 1940.

TENNESSEE PHOSPHATE

Good Weather Aids All Shipments. New Construction Proceeding Vigorously. Probable Advance in Rock Prices.

Exclusive Correspondence to "The American Fertilizer."

COLUMBIA, TENN., April 21, 1941.

Fine spring, almost summer, weather promotes the activities of all lines in the phosphate area and shipments of phosphate rock continues to move with rapidity into all consuming channels.

Shipments of ground rock for direct application are over 30 per cent larger than for same period of 1940, and judging from the steady stream of trucks loaded with commercial fertilizer going both north and south, farmers are using it freely in anticipation of better prices for farm crops.

The TVA is asking bids for 65,000 tons of 70 per cent rock, and both Monsanto and Victor plants are operating full.

Construction work is proceeding vigorously on the TVA plants at their Bear Creek mines and the sintering and shipping plant north of Godwin on the L. & N. R.R. near Columbia.

The costs of operations in phosphate mining, of course, show the general trend of increase in all industrial circles and the price of phosphate rock would have advanced more than it has, except for the surplus in Florida. As that is absorbed by increased domestic consumption, which has already followed the course of 1920 by reaching 4,000,000 tons, a price surge need not be unexpected at any time.

CHICAGO

Better Inquiry for Fertilizer Organics Developing. Feed Materials at Higher Prices.

Exclusive Correspondence to "The American Fertilizer."

CHICAGO, April 21, 1941.

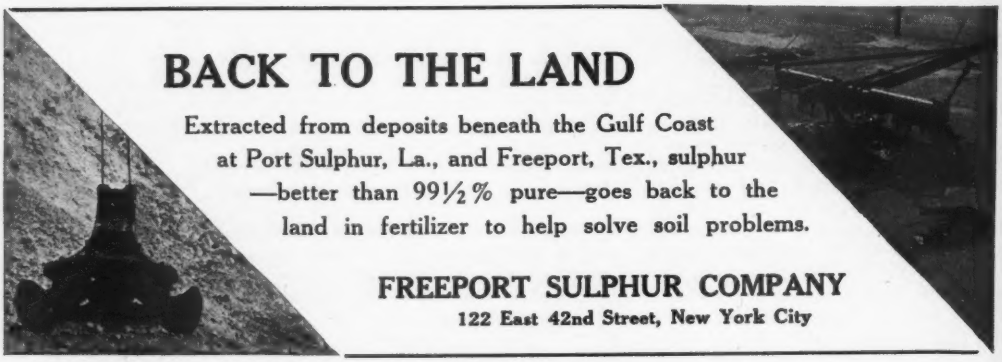
Continued interest for future deliveries of organics is in evidence, and further trades have been made. Just why the strong buying desire developed so early in the season is not clear, though seemingly the defense and commodity price stabilization programs, together with the cessation of imports of nitrogenous material, have some bearing.

Raised list prices of digester tankage and meat scrap caused feed materials to advance to near top prices for the year.

Nominal prices are as follows: High grade ground fertilizer tankage, $2.20 to $2.25 ($2.67½ to $2.73½ per unit N) and 10 cents; standard grades crushed feeding tankage, $3.75 to $3.85 ($4.56 to $4.68 per unit N) and 10 cents; blood, $3.50 to $3.60 ($4.25½ to $4.37½ per unit N); dry rendered tankage, 80 to 85 cents per unit of protein, Chicago basis.

POTASH INSTITUTE MOVES OFFICES

The American Potash Institute is announcing the removal of its main offices on April 26th to the American Chemical Society Building, 1155 Sixteenth Street, Washington, D. C. The Institute, since 1935 located in the Investment Building in Washington, has taken an entire floor in the building recently acquired by the American Chemical Society.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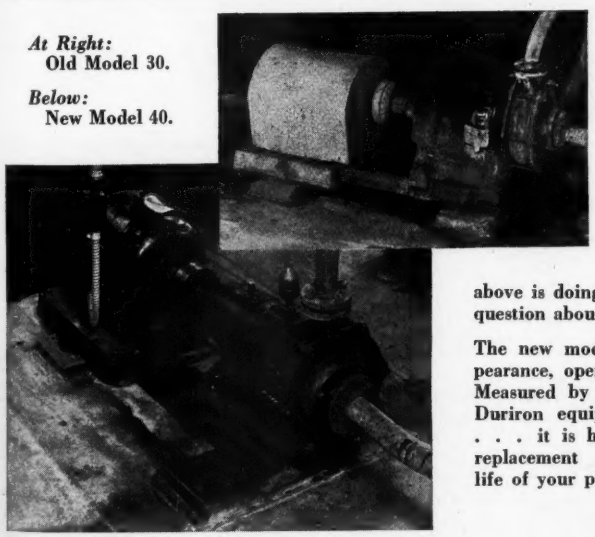
Below:
New Model 40.



"THE PROOF *of the* PUDDING"

A large fertilizer manufacturer recently wrote for a new Model 40 Duriron Pump as additional equipment to handle sulphuric acid.

The old Model 30 Duriron Pump shown above is doing such excellent work that there wasn't any question about the pump he wanted.

The new models set new standards in streamlined appearance, operating efficiency and low-cost maintenance. Measured by the yardstick of efficiency and economy, Duriron equipment is always a source of satisfaction . . . it is highly corrosion resistant . . . needs no replacement . . . performs faithfully throughout the life of your plant.

Corrosion-resistant Pumps and Valves for handling Sulphuric Acid at all strengths and temperatures, Nitrous Vitriol, Phosphoric Acid and Ammonia Compounds.

Write for 1941 Bulletins

THE DURIRON CO., Inc., DAYTON, OHIO

DURIRON · DURICHLOR
CORROSION-RESISTING
DURCO
ALLOYS & EQUIPMENT
THE DURIRON CO. INC.
DAYTON OHIO
DURIMET · DURCO STAINLESS STEELS

DEVELOPMENTS IN FERTILIZER ANTI-TRUST SUIT

(Continued from page 11)

allegations of the indictment and various phases of the suit in relation to the Association were discussed. Instructions were given that a plea of "not guilty" be entered on behalf of the Association at the arraignment on May 12th. Some of the Board members felt that the Association should take an active lead in making plans for the preparation of the defense. Necessary preliminary study of the case by counsel and suggestions for counsel to head-up the entire defense, pursuant to the suggestion of Judge Hayes, were discussed.

7. Meeting of All Defendants. Pursuant to action by the Executive Committee, a meeting at Philadelphia on April 17th, to which all the defendants and their counsel have been invited, has been arranged by the Association. The meeting will be held at Philadelphia because of congested hotel conditions in Washington. Defendants will bring their counsel if they so desire. This meeting will be open for the discussion of preliminary procedure, including the entry of pleas, matters of policy, coordinated study of the case, employment of counsel, and any other appropriate matter.

8. *Defense Conferences Sanctioned by Court.* At a session of the Court held on March 10th, Judge Hayes expressly said that the Court would not suffer any reference to be made to the jury in the trial of the case because the defendants conferred in the preparation of the defense, it being as necessary for them to confer as for counsel for the prosecution to confer.

At the meeting at Philadelphia on April 17th, an advisory committee was selected, consisting of W. T. Wright, chairman; A. L. Ivey; John A. Miller; R. B. Douglass; George W. Gage; George Cushman; Charles J. Brand. This committee will make such recommendations and take such interim action as deemed necessary.

USE OF LIQUID FERTILIZERS FOR GROWING VEGETABLES

(Continued from page 10)

liquid fertilizer per acre. *Special pumping machines* which pump the water out of the tank are available. They apply the solution at a more uniform rate, and are easily regulated to apply 5, 10, 15, 20, or 25 gallons per minute.

Quantities of Fertilizers to Use in Solutions

The following tabulation gives the amounts of mixed fertilizers in 50 gallons of water that may be used for different purposes when applied in liquid form.

Amounts of Mixed Fertilizers to Use in 50 Gallons of Water, Based on Total Application of 200 Gallons of Solution per Acre

STARTER SOLUTIONS

Nitrogen Content of Mixed Fertilizer	For Transplanting (Tomato, cabbage, pepper, eggplants, sweet potatoes) — Amount in 50 Gallons of Water		For Seed Sowing (Beans, corn, peas) — Amount in 50 Gallons of Water	
	With Dry Fertilizer in Row	With Dry Fertilizer Broadcast*	In Furrow with Seed	As Side-Dressings
3 to 8%	None	4 to 10 lb.	10 to 40 lb.	25 to 50 lb.
8 to 15%	None	2 to 4	5 to 10	10 to 25
15 to 25%	None	1 to 3	2 to 6	5 to 10

* Before or after plowing.

SIDE-DRESSINGS

Crop	Amount in 50 Gallons of Water	Number of Applications	Intervals after Planting
Sweet corn, snap beans, spinach	10 to 25 lb.	1	At emergence.
Lima beans	10 to 25	3	Every 2 weeks.
Tomatoes, eggplants	20 to 50	3-4	Every 2 weeks.
Sweet potatoes, peppers	10 to 25	3	Every 2 weeks.
Cabbage, cauliflower, broccoli	20 to 50	4	Every 2 weeks.

Stedman FERTILIZER PLANT EQUIPMENT
Dependable for Fifty Years
Founded 1834
All-Steel Self-Contained Fertilizer Mixing Units
Batch Mixers—Dry Batching
Pan Mixers—Wet Mixing
Swing Hammer and Cage Type Tailings Pulverizers
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CHILEAN NITRATE OF SODA

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Bone Meals

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SOUTH AMERICAN DRY RENDERED TANKAGE

•

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Charleston, S. C.

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Production
Recovery
Concentration

Whether your production requirements involve large or small quantities, consult the CHEMICO engineers for authoritative advice and recommendations. CHEMICO designs, remodels and builds complete acid and fertilizer plants, and CHEMICO recommendations are based on 26 years of specialized experience. Your inquiry is invited, and will involve no obligation.

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CHEMICO PLANTS are PROFITABLE INVESTMENTS

SPECIFY

THREE ELEPHANT

BORAX

REG. U.S. PAT. OFF.

. . . . WHEN BORON IS NEEDED TO CORRECT A DEFICIENCY OF THIS IMPORTANT SECONDARY ELEMENT

Agricultural authorities have shown that a lack of Boron in the soil can result in deficiency diseases which seriously impair the yield and quality of crops.

When Boron deficiencies are found, follow the recommendations of local County Agents or State Experiment Stations.

Information and references available on request.

AMERICAN POTASH & CHEMICAL CORPORATION
70 PINE STREET, NEW YORK CITY
Pioneer Producers of Muriate of Potash in America

See Page 4

PARITY RATES FOR 1941

Rates of parity payments to growers who plant within their 1941 acreage allotments of cotton, wheat, corn, rice, and tobacco have been announced by the Department of Agriculture. Payments will be based on nominal yields of each producer's acreage allotment at the following rates: cotton, 1.38 cents per lb.; wheat, 10 cents per bushel; corn, 5 cents per bushel; rice, 20 cents per cwt.; flue-cured tobacco, 0.6 cents per lb.; fire-cured tobacco, 0.2 cents per lb.; cigar filler, cigar binder (not including types 41 and 45), 0.7 cents per lb. Payments are to be made from a $212,000,000 fund provided by the 1941 Department of Agriculture Appropriation Act, in accordance with provisions of AAA of 1938.

SOIL ORGANIC MATTER

(Continued from page 8)

plots, both with and without fertilizers, the greatest being shown by the unfertilized corn.

In rotations of corn and oats and clover, that without manure or fertilizer showed less organic carbon that the grassland comparison, while the rotation which had received M, L, and rP showed a gain over nearby grassland.

Table 5

Influence of Soil Management

Rotation	Per Cent Organic Carbon	Per Cent Water Holding Capacity
Corn continuous (no fert.)..	1.7	56.0
Corn continuous (M, L, rP*)	2.2	62.5
Corn, oats, clover (no fert.)	2.25	63.0
Corn, oats, clover (fert.)....	2.9	75.0
Grass, near edge of plot....	2.5	73.0

* M, manure; L, lime; rP, rock phosphate.
Stauffer, R. S., J. Am. Soc. Agron. **28** (1936).

Seitz,[8] reporting on soil and water investigations from the Virginia Polytechnic Institute (June, 1940) presents data on the effect of top-dressing with superphosphate on permanent pastures. (Tables 6 and 7.) In one test in which superphosphate had been applied since 1917, the organic matter in the surface 0-2 in. was 96 per cent greater than in the untreated section, the 2 in.-6 in. layer showing a 18.3 per cent increase.

On plots started in 1933, and fertilized annually since, the organic matter content was

[8] Seitz, D. C., V. P. I. Multi. Rpt., No. 1 (June, 1940).

Table 6

Effect of Fertilizers

Treatment		Per Cent Aggregate	Increase	Organic Matter	Increase
Fert., 1917.	0-2 in.	77.4	21.0	7.93	95.8
Check.....	0-2 in.	64.0	...	4.05	...
Fert., 1917.	2-6 in.	77.5	4.3	3.16	18.3
Check.....	2-6 in.	74.3	...	2.67	...

V. P. I. Multi. Rpt. No. 1 (June, 1940).

Table 7

Effect of Fertilizers

Treatment		Per Cent Aggregate	Increase	Organic Matter	Increase
Fert., 1933.	0-2 in.	76.2	19.0	6.30	55.6
Check.....	0-2 in.	64.0	...	4.05	...
Fert., 1933.	2-6 in.	79.5	7.0	3.29	23.2
Check.....	2-6 in.	74.3	...	2.67	...

V. P. I. Multi. Rpt. No. 1 (June, 1940).

55 per cent greater on the treated than on the untreated soil, with the 2 in.-6 in. layer showing a 23 per cent gain.

Soil structure was studied in this work. The water stable aggregates were 21 and 19 per cent higher in the superphosphated plots in the 0-2 in. layer when compared with the check, while in the substratum the increase was 4.3 and 7.0 per cent respectively.

In New Hampshire[9] we have been studying the effect of certain three-year rotations on the soil organic matter. In the rotations studied, (Table 8) one covering six years, the other twelve, by and large, these rotations have tended to deplete the organic matter supply of the soils. This loss has amounted to as much as one per cent each year in the 12-year test, and to a maximum of 1.3 per cent of the total supply in one year in the 6-year rotation.

Going against this trend, limed plots in the 6-year trial show a gain of organic matter, and

Table 8

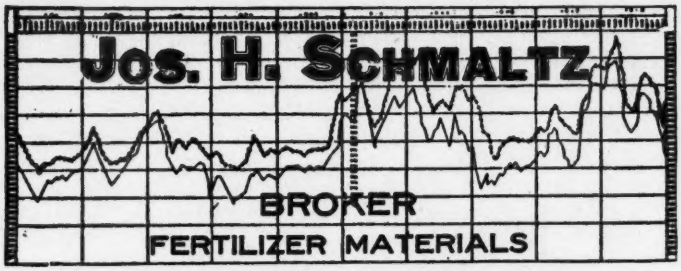
Organic Matter Trends in 3-Year Rotations

Treatment All Fert. on Potatoes	Total Gain or Loss, Per Cent Lane Farm, 6 Yrs.	Jackson, 12 Yrs.
1 ton 4-8-7	—3.80	—12.5
1 ton 4-0-7	—7.99	.....
1 ton 4-16-7	—3.14	— 4.3
1 ton 4-8-0	—2.48	.....
1 ton 4-8-14	—5.00	—13.1
1 ton 4-8-7 L	+4.29	—10.2
1 ton 4-8-7 2L	+2.95	.....

[9] Coates, W. H., Bull. 324, N. H. Exp. Sta.

L. W. HUBER COMPANY
Brokers Fertilizer Materials
ROOM 903
170 Broadway
New York, N.Y.

Tankage
Blood
Bone
All
Ammoniates



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CATALOGUES
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PRINTING SERVICE

show a lower loss than certain other series in the 12-year trial. In the 12-year test, the high phosphorus plots show less loss than other series, and this same treatment exhibits a lower loss than most of the other treatments in the 6-year trial.

It seems advisable, now, to present some data relating specifically to the effect of organic substances on crop production. For this, I have taken some work on potatoes from both Maine and New Hampshire, data for which are given in Tables 9 and 10.

Table 9

Effect of Organic Matter on Potato Yields

Treatment	Yield, Bu. per Acre
Stubble only	411
One green crop	450
Two green crops	493
One green crop + 6 tons straw	537
One green crop + 20 tons manure	567

Chucka and Lovejoy,[10] Me. Bull. 377, Two-Yr. Rot. Exp.

Table 10

Effect of Manure on Potatoes

Treatment	Yield, Bu. per Acre
Maine Continuous Potatoes:	
2,000 lb. 4-8-7	359
2,000 lb. 4-8-7 20 tons manure	533
New Hampshire[11]:	
No manure or fert.	137
12 tons manure	225
24 tons manure	260

Summary

In order not to leave you in confusion, perhaps it might be desirable to summarize.

The organic matter under any given climatic condition tends to reach a certain level, depending upon the temperature, rainfall, and precipitation-evaporation ratio. This means that in New England, the soils are better supplied with organic matter than those of Virginia. By that, I do not mean that we should be careless about our cropping systems, soil management, or fertilizer practices.

Crop rotation in and of itself is not sufficient to maintain the organic matter supply.

Crop rotation, coupled with manure, fertilizer and suitable liming practices tends to maintain or increase the organic matter level. This is due, partly, at least, to the greater bulk of roots produced by larger crops.

Hay crops, in themselves, tend to conserve organic matter and to increase the supply in the soil.

Cultivated crops have the reverse effect.

Data presented from three-year rotations, even with second-year crop hay plowed under, show a loss of organic matter, where no manure was applied.

Top-dressing sod land, even with superphosphate, causes relatively large increases in organic matter.

Any increase in organic matter is likely to be accompanied by a beneficial effect on soil structure which in turn puts the soil into better tilth, causes it to have a greater infiltration and water-holding capacity, and renders it less susceptible to erosion.

From what has been said, it is rather easy to lay one's finger on the danger spots in New England farming. Potato and vegetable growers, who are the largest users of fertilizer, are the ones whose soils are most likely to suffer. Dairymen, with long rotations and plenty of manure at hand probably mostly maintain their organic matter. But potato and other cash crop farmers are in danger on this score, and it is easy to point out examples of men who are already suffering because of it. Longer rotations, the use of more land, the growth of more green crops, and the introduction of some kind of livestock into the farming system is an obvious way out for them.

[10] Chucka and Lovejoy, Bull. 377, Me. Agr. Exp. Sta.
[11] Prince, F. S., *et al.*, Extension Bull. 45, N. H. Ext. Service.

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To make clearer its use, answers to such problems as the following can be quickly obtained:

How much sulphate of ammonia, containing 20 per cent. of nitrogen, would be needed to give 4½ per cent. nitrogen in the finished product?

Seven hundred and fifty pounds of tankage, containing 8 per cent. phosphoric acid are being used in a mixture. What per cent. of phosphoric acid will this supply in the finished goods?

Should the Adams' Formula Rule become soiled from handling, it may be readily cleaned with a damp cloth.

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BUYERS' GUIDE

A CLASSIFIED INDEX TO ALL THE ADVERTISERS IN "THE AMERICAN FERTILIZER"

This list contains representative concerns in the Commercial Fertilizer Industry, including fertilizer manufacturers, machinery and equipment manufacturers, dealers in and manufacturers of commercial fertilizer materials and supplies, brokers, chemists, etc.
For Alphabetical List of Advertisers, see page 33.

ACID BRICK
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

ACID EGGS
Chemical Construction Corp., New York City.

ACIDULATING UNITS
Chemical Construction Corp., New York City.
Sackett & Sons Co., The A. J., Baltimore, Md.

AMMO-PHOS
American Cyanamid Co., New York City.

AMMONIA—Anhydrous
Barrett Company, The, New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.
Hydrocarbon Products Co., New York City.

AMMONIA LIQUOR
Barrett Company, The, New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.
Hydrocarbon Products Co., New York City.

AMMONIA OXIDATION UNITS
Chemical Construction Corp., New York City.

AMMONIATING EQUIPMENT
Sackett & Sons Co., The A. J., Baltimore, Md.

AMMONIUM NITRATE SOLUTIONS
Barrett Company, The, New York City

AUTOMATIC ELEVATOR TAKEUPS
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

BABBITT
Sackett & Sons Co., The A. J., Baltimore, Md.

BAGS AND BAGGING—Manufacturers
Bagpak, Inc., New York City.
Bemis Bro. Bag Co., St. Louis, Mo.

BAGS—Cotton
Bemis Bro. Bag Co., St. Louis, Mo.

BAGS—Paper
Bagpak, Inc., New York City.
Bemis Bro. Bag Co., St. Louis, Mo.

BAGS (Waterproof)—Manufacturers
Bemis Bro. Bag Co., St. Louis, Mo.

BAGS—Dealers and Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

BAGGING MACHINES—For Filling Sacks
Atlanta Utility Works, East Point, Ga.
Bagpak, Inc., New York City.
Sackett & Sons Co., The A. J., Baltimore, Md.

BAG PILERS
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.

BEARINGS
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

BELT LACING
Sackett & Sons Co., The A. J., Baltimore, Md.

BELTING—Chain
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

BELTING—Leather, Rubber, Canvas
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.

BOILERS—Steam
Atlanta Utility Works, East Point, Ga.

BONE BLACK
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Huber & Company, New York City.

BONE PRODUCTS
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
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Bradley & Baker, New York City.
Huber & Company, New York City.
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McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

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Pacific Coast Borax Co., New York City.

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Bradley & Baker, New York City.
Huber & Company, New York City.
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Keim, Samuel L., Philadelphia, Pa.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

BUCKETS—Elevator
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
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Menhaden Fish Products and Fertilizer Materials

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For an Alphabetical List of all the Advertisers, see page 33

BUCKETS—For Hoists, Cranes, etc., Clam Shell, Orange Peel, Drag line, Special; Electrically Operated and Multi Power
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.

BURNERS—Sulphur
Chemical Construction Corp., New York City.

BURNERS—Oil
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.

CABLEWAYS
Hayward Company, The, New York City.

CARBONATE OF AMMONIA
American Agricultural Chemical Co., New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.

CARS—For Moving Materials
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CARTS—Fertilizer, Standard and Roller Bearing
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

CASTINGS—Acid Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.

CASTINGS—Iron and Steel
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CEMENT—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

CHAIN DRIVES—Silent
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

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Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
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Stedman's Foundry and Mach. Works, Aurora, Ind.

CHAMBERS—Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

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Duriron Co., Inc., The, Dayton, Ohio.
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Baker & Bro., H. J., New York City.
Barrett Company, The, New York City.
Bradley & Baker, New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.

CHEMICALS—Continued
Huber & Company, New York City.
Phosphate Mining Co., The, New York City.
Wellmann, William E., Baltimore, Md.

CHEMICAL PLANT CONSTRUCTION
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
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Wiley & Company, Baltimore, Md.

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Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CONCENTRATORS—Sulphuric Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

CONDITIONERS AND FILLERS
American Limestone Co., Knoxville, Tenn.
Phosphate Mining Co., The, New York City.

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Tennessee Corporation, Atlanta, Ga.

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Huber & Company, New York City.
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Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

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Link-Belt Company, Philadelphia, Chicago.
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Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

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BUYERS' GUIDE

For an Alphabetical List of all the Advertisers, see page 33

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Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

DRYERS—Direct Heat
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons Co., The A. J., Baltimore, Md.

DRIVES—Electric
Link-Belt Company, Philadelphia, Chicago.

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Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

DUST COLLECTING SYSTEMS
Sackett & Sons Co., The A. J., Baltimore, Md.

ELECTRIC MOTORS AND APPLIANCES
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

ELEVATORS
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ELEVATORS AND CONVEYORS—Portable
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

ENGINEERS—Chemical and Industrial
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ENGINES—Steam
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

EXCAVATORS AND DREDGES—Drag Line and Cableway
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Link Belt Speeder Corp., Chicago, Ill., and Cedar Rapids, Iowa.

FERTILIZER MANUFACTURERS
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Farmers Fertilizer Co., Columbus, Ohio
International Agricultural Corp., New York City.
Phosphate Mining Co., The, New York City.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.

FISH SCRAP AND OIL
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

FOUNDERS AND MACHINISTS
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

GARBAGE TANKAGE
Wellmann, William E., Baltimore, Md.

GEARS—Machine Moulded and Cut
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

GEARS—Silent
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

GELATINE AND GLUE
American Agricultural Chemical Co., New York City.

GUANO
Baker & Bro., H. J., New York City.

HOISTS—Electric, Floor and Cage Operated, Portable
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.

HOPPERS
Atlanta Utility Works, East Point, Ga.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

IMPORTERS, EXPORTERS
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

IRON SULPHATE
Tennessee Corporation, Atlanta, Ga.

INSECTICIDES
American Agricultural Chemical Co., New York City.

LACING—Belt
Sackett & Sons Co., The A. J., Baltimore, Md.

LIMESTONE
American Agricultural Chemical Co., New York City.
American Limestone Co., Knoxville, Tenn.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

LOADERS—Car and Wagon, for Fertilizers
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Acid Making
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
Duriron Co., Inc., The, Dayton, Ohio.
Fairlie, Andrew M., Atlanta, Ga.
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Coal and Ash Handling
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Elevating and Conveying
Atlanta Utility Works, East Point, Ga.
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

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MACHINERY—Power Transmission
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Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Pumping
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Duriron Co., Inc., The, Dayton, Ohio.

MACHINERY—Tankage and Fish Scrap
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MAGNETS
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Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MANGANESE SULPHATE
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Tennessee Corporation, Atlanta, Ga.

MIXERS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

NITRATE OF SODA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Company, The, New York City.
Bradley & Baker, New York City.
Chilean Nitrate Sales Corp., New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

NITRATE OVENS AND APPARATUS
Chemical Construction Corp., New York City.

NITROGEN SOLUTIONS
Barrett Company, The, New York City

NITROGENOUS ORGANIC MATERIAL
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
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DuPont de Nemours & Co., Wilmington, Del.
Huber & Company, New York City.
International Agricultural Corp., New York City.
McIver & Son, Alex. M., Charleston, S. C.
Smith-Rowland Co., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

NOZZLES—Spray
Monarch Mfg. Works, Philadelphia, Pa.

PACKING—For Acid Towers
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

PANS AND POTS
Stedman's Foundry and Mach. Works, Aurora, Ind.

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Chemical Construction Corp., New York City.

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Ashcraft-Wilkinson Co., Atlanta, Ga.
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Bradley & Baker, New York City.
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Huber & Company, New York City.
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Schmaltz, Jos. H., Chicago, Ill.
Southern Phosphate Corp., Baltimore, Md.
Taylor, Henry L., Wilmington, Del.
Wellmann, William E., Baltimore, Md.

PIPE—Acid Resisting
Duriron Co., Inc., The, Dayton, Ohio.

PIPES—Chemical Stoneware
Chemical Construction Corp., New York City.

PIPES—Wooden
Stedman's Foundry and Mach. Works, Aurora, Ind.

PLANT CONSTRUCTION—Fertilizer and Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

POTASH SALTS—Dealers and Brokers
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Agricultural Corp., New York City.
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, Del.
Wellmann, William E., Baltimore, Md.

POTASH SALTS—Manufacturers and Importers
American Potash and Chem. Corp., New York City.
Potash Co. of America, Baltimore, Md.
United States Potash Co., New York City.

PULLEYS AND HANGERS
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

PUMPS—Acid-Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

PYRITES—Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., New York City.
Jett, Joseph C., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

QUARTZ
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

RINGS—Sulphuric Acid Tower
Chemical Construction Corp., New York City.

ROUGH AMMONIATES
Bradley & Baker, New York City.
Schmaltz, Jos. H., Chicago, Ill.
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Link-Belt Company, Philadelphia, Chicago.
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SEPARATORS—Air
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Including Vibrating
Link-Belt Company, Philadelphia, Chicago.
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Sackett & Sons Co., The A. J., Baltimore, Md.
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SHAFTING
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
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Stedman's Foundry and Mach. Works, Aurora, Ind.

SHOVELS—Power
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corp., Chicago, Ill., and Cedar Rapids, Iowa.
Sackett & Sons Co., The A. J., Baltimore, Md.

SPRAYS—Acid Chambers
Monarch Mfg. Works, Inc., Philadelphia, Pa.

SPROCKET WHEELS (See Chains and Sprockets)

STACKS
Sackett & Sons Co., The A. J., Baltimore, Md.

SULPHATE OF AMMONIA
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Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
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Freeport Sulphur Co., New York City.
Texas Gulf Sulphur Co., New York City.

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Taylor, Henry L., Wilmington, N. C.

SULPHURIC ACID—Continued
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE
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Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
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Schmaltz, Jos. H., Chicago, Ill.
Taylor, Henry L., Wilmington, N. C.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE—Concentrated
Armour Fertilizer Works, Atlanta, Ga.
International Agricultural Corp., New York City.
Phosphate Mining Co., The, New York City.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.

SYPHONS—For Acid
Monarch Mfg. Works, Inc., Philadelphia, Pa.

TALLOW AND GREASE
American Agricultural Chemical Co., New York City.

TANKAGE
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
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Smith-Rowland, Norfolk, Va.
Taylor, Henry L., Wilmington, N. C.
Wellmann, William E., Baltimore, Md.

TANKAGE—Garbage
Huber & Company, New York City.

TANKS
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Sackett & Sons, Co., The A. J., Baltimore, Md.

TILE—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

TOWERS—Acid and Absorption
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

UNLOADERS—Car and Boat
Hayward Company, The, New York City.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

UREA
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UREA-AMMONIA LIQUOR
DuPont de Nemours & Co., E. I., Wilmington, Del.

VALVES—Acid-Resisting
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Jeffrey Manufacturing Co., The, Columbus, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

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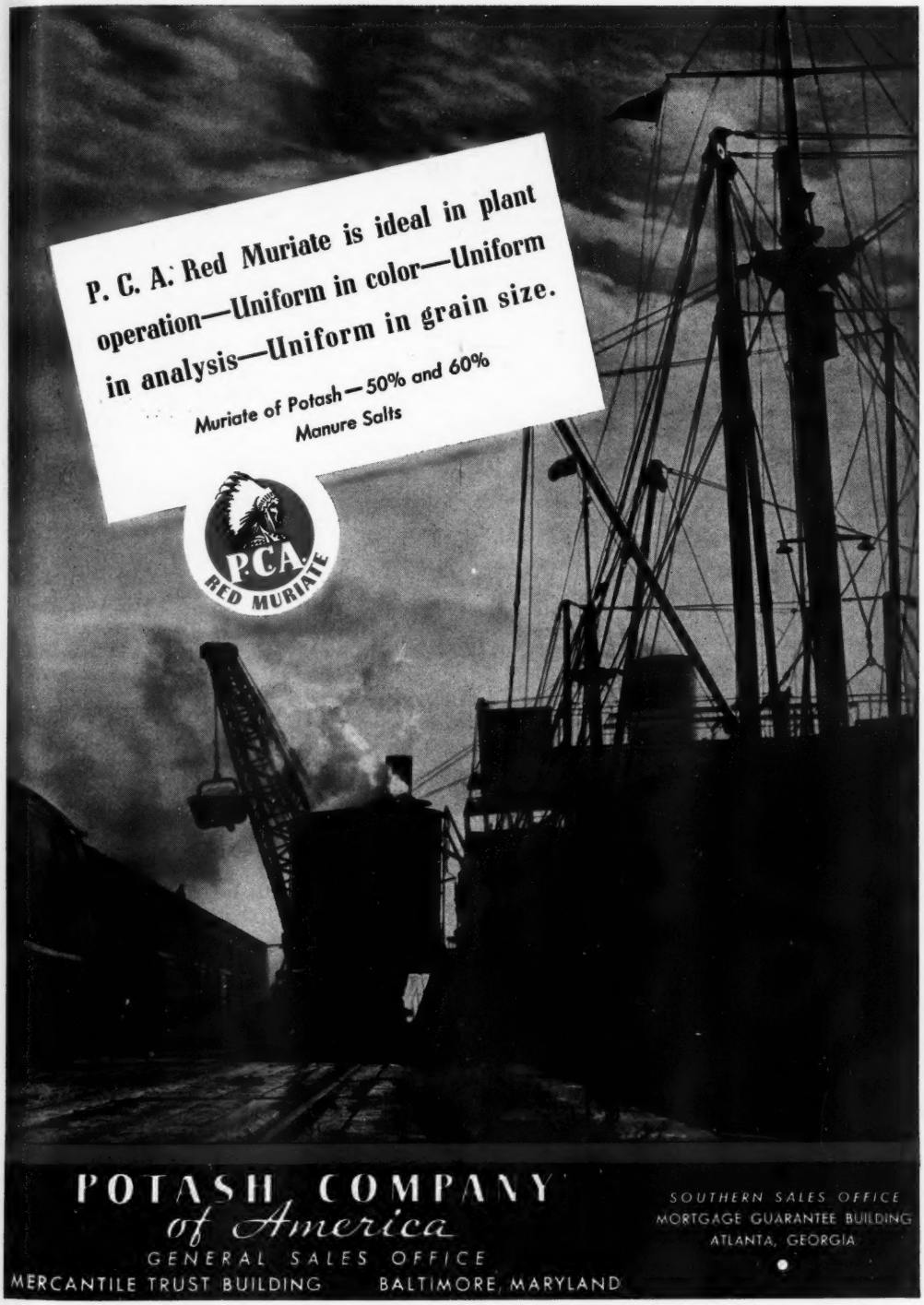
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